NORTH ATLANTIC TREATY ORGANIZATION
ORGANISATION DU TRAITE DE L'ATLANTIQUE NORD

MILITARY AGENCY FOR STANDARDIZATION (MAS)
BUREAU MILITAIRE DE STANDARDISATION (BMS)
1110 BRUSSELS

MAS/92-MMS/4236
8 March 1993

To : See MAS Distribution List No. 2

Subject : STANAG 4236 MMS (EDITION 1) - LIGHTNING ENVIRONMENTAL CONDITIONS, AFFECTING THE DESIGN OF MATERIEL, FOR USE BY THE NATO FORCES

Reference : AC/310-D/88 dated 25 January 1990

Enclosure : STANAG 4236 (Edition 1)

1. The enclosed NATO Standardization Agreement which has been ratified by nations as reflected in page iii is promulgated herewith.

2. The reference listed above is to be destroyed in accordance with local document destruction procedures.

3. AAP-4 should be amended to reflect the latest status of the STANAG.

ACTION BY NATIONAL STAFFS

4. National staffs are requested to examine page iii of the STANAG and if they have not already done so, to advise the Defence Support Division, IS, through their national delegation as appropriate of their intention regarding its ratification and implementation.

E. STAI
Major-General, NOAF
Chairman, MAS

STANAG 4236
(Edition 1)

NORTH ATLANTIC TREATY ORGANIZATION

(NATO)

MILITARY AGENCY FOR STANDARDIZATION

(MAS)

STANDARDIZATION AGREEMENT

SUBJECT : LIGHTNING ENVIRONMENTAL CONDITIONS, AFFECTING THE DESIGN OF MATERIEL, FOR USE BY THE NATO FORCES

Promulgated on 8 March 1993

E. Stai

E. STAI
Major-General, NOAF
Chairman, MAS

RECORD OF AMENDMENTS

No.	Reference/date of amendment	Date entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Chairman MAS under the authority vested in him by the NATO Military Committee.

2. No departure may be made from the agreement without consultation with the tasking authority. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

DEFINITIONS

4. Ratification is "The declaration by which a nation formally accepts the content of this Standardization Agreement".

5. Implementation is "The fulfilment by a nation of its obligations under this Standardization Agreement".

6. Reservation is "The stated qualification by a nation which describes that part of this Standardization Agreement which it cannot implement or can implement only with limitations".

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

7. Page iii gives the details of ratification and implementation of this agreement. If no details are shown it signifies that the nation has not yet notified the tasking authority of its intentions. Page iv (and subsequent) gives details of reservations and proprietary rights that have been stated.

Agreed English/French Texts

STANAG 4236
(Edition 1)

NAVY/ARMY/AIR

NATO STANDARDIZATION AGREEMENT (STANAG)

LIGHTNING ENVIRONMENTAL CONDITIONS, AFFECTING THE DESIGN OF MATERIEL, FOR USE BY THE NATO FORCES

Annexes:

A. Definitions
B. Lightning description and environmental parameters
C. Minimum design criteria for munitions and associated systems

Related Document: None

AIM

1. The aim of this agreement is:

   (a) to describe the lightning environment which may be experienced by materiel and particularly by munitions and associated systems.

   (b) to define the threat levels to be used as minimum design criteria for all new munitions and associated systems intended for use by the NATO forces.

AGREEMENT

2. Participating Nations Agree

   (a) that the lightning environment as described in Annex B may be encountered by materiel during NATO operations.

   (b) to specify the threat levels as defined in Annex C as minimum design criteria for all new munitions and associated systems intended for use by NATO forces.

   (c) that the NATO forces consider this STANAG as a basis for continuing a working relationship on lightning and related environmental matters.

DEFINITIONS

See Annex A

IMPLEMENTATION OF THE AGREEMENT

3. This STANAG is considered to be implemented by a nation when that nation has issued the necessary order/instructions that all newly developed munitions procured for its forces will be designed to remain safe and if specified, suitable for service when exposed to the lightning environment defined in this agreement.

DEFINITIONS

The following definitions are used for the purpose of this agreement only.

NOTE: For clarity, these definitions are given for cloud-to-ground discharges but, with appropriate changes, may also apply to intercloud and intra-cloud discharges.

1. FLASH

The total lightning discharge.

2. LEADER

A preliminary breakdown that forms an ionised path.

3. STROKE

A component discharge of a lightning flash, which follows a leader.

4. FIRST RETURN STROKE

That current flow along the previously ionised path occurring when that path is complete from cloud to ground.

5. SUBSEQUENT RETURN STROKES-RESTRIKES

These strokes occuring after the first return stroke in a multi-stroke flash.

6. INTERMEDIATE CURRENT PHASE

That current of a few kiloamperes which may persist for several milliseconds after the initial decay of a return stroke.

7. CONTINUING CURRENT PHASE

That current which may occur between strokes and more often after the last stroke.

This current has the lowest current amplitude (between 200 and 800 A) but the longest duration. It is in this phase that the largest charge transfer usually occurs.

8. ACTION INTEGRAL

The energy in any portion of the current path per ohm resistance. The action integral $\int i(t)^2 dt$ is measured in A^2s.

9. STRIKE

A lightning discharge which interacts with the object (system).

10. DIRECT STRIKE

A lightning discharge which attaches directly to the object (system) considered and actual lightning current flows in parts or the whole of that object (system).

11. NEARBY STRIKE

A lightning discharge which does not attach itself to the object (system), but, due to its proximity, may induce significant current in the object (system) either by electric field coupling, magnetic field coupling, ground currents, or by a combination of all three.

12. FAR FIELD STRIKE

A lightning discharge which occurs at such a distance that the only coupling to the object (system) is by electromagnetic radiation.

LIGHTNING DESCRIPTION AND ENVIRONMENTAL PARAMETERS

1. BACKGROUND

Lightning is a natural electrical discharge (e.g. cloud to cloud, intracloud or cloud to ground) produced when the electric field resulting from storage of electrical charges in clouds reaches the local breakdown level.

The number of thunderstorms in progress throughout the world at any instant in time is at a level between 2000 and 5000. This produces about 100 electrical discharges every second. In general the total sum of cloud to cloud and intracloud discharges greatly exceeds the number of cloud to ground discharges

The probability of lightning occuring is considerably greater over large land masses than over oceans.

Lightning discharges are all unique, and can only be defined or quantified on a statistical basis. Statements of the values of various parameters are derived from ground measurements, and will vary with the area in which the measurements were made. It is not possible therefore to quote the figures nor apply them with the same precision that is normal in other branches of electrical science.

2. LIGHTNING MECHANISM

Discharges to ground from the negatively charged part of the cloud are called negative flashes and from the positively charged part of the cloud, positive flashes.

The negative charge is in the lower part of the cloud whilst most of the positive charge is in the upper part of the cloud. For this reason something approaching 90% of all discharges to ground are negative flashes. Graphical representations of negative and positive lightning flashes are shown in Figures 1(A) and (B).

The typical lightning flash, which may have a duration of up to one second, has two stages.

(a) the first stage of a discharge to ground is the formation of a leader (see definition 2) made up of an ionization front generated at a point(s) of high stress in the cloud. This leader propagates downwards towards the ground. There is a responding leader from a point(s) of high stress on the ground. This responding leader propagates upwards towards the cloud. The two leaders are weakly ionized and carry only the small current required to maintain ionization.

The two leaders can meet either close to the ground when it is termed "downwards going leader" or close to the cloud when it is termed "an upwards going leader". They do not meet halfway.

When the two leaders meet, there is a conducting path between the charged cloud and the ground.

(b) The first stage is followed by return current impulses called "strokes" (see definition 3). When measured at ground level, the negative flash usually has a number of return strokes which may be interspaced by comparatively weak "intermediate currents" (see definition 6) and there may also be a "continuing current phase" (see definition 7). When measured at ground level, the positive flash usually has only one return stroke of longer duration and longer time to peak current than a negative return stroke.

The data given in Tables 1 & 2 are all based on ground level measurements that have been observed in different geographical locations. Because of the changes in parameter values that take place with changes in altitude the values given should be interpreted with caution.

In considering the far field parameters shown in Figure 2 it should be noted that the whole of the lightning channel contributes to the far field conditions, and the differences observed at ground level between upwards and downwards going leaders do not apply.

In computer models of the lightning channel it has been observed that the return stroke from a downwards going leader has the characteristics at ground level of a "negative discharge", but at or near to the cloud the discharge is a single pulse. The return stroke from an upwards going leader has the characteristics at ground level of the "positive discharge", but near to the cloud characteristics tend to change to those of the "negative discharge". It is interesting to note most negative discharges have a downwards going leader whilst most of the positive discharges have an upwards going leader. This may be the explanation of the characteristic differences observed in the negative and positive discharges to ground when measured at ground level.

PARAMETERS FOR NEGATIVE LIGHTNING FLASH MEASURED AT GROUND LEVEL

PARAMETERS	UNIT	LIGHTNING PARAMETERS AVERAGE (50%)	SEVERE (2%)
Number of strokes		3	11
Time intervals between strokes	ms	60	320
Peak current (1st stroke)	kA	20	200
Peak rate of rise (1st stroke)	A/s	2.2×10^{10}	3×10^{10}
Time to peak (all strokes)	us	1.8	1.2
Pulse width at half peak current (all strokes)	us	45	170
Peak current (subsequent strokes)	kA	10	100
Peak rate of rise (subsequent strokes	A/s	2.2×10^{10}	1×10^{11}
Amplitude of continuing current	A	140	500
Duration of continuing current	s	0.16	0.5
Charge passed in continuing current	C	26	110
Action integral	A^2s	2×10^4	10^6
Charge per stroke	C	5	20
Total charge in flash	C	15	200
Flash duration	s	0.18	1

TABLE 1

Note: The individual parameters indicated above are approximate and represent a consensus of experimental measurements. They do not necessarily occur together in one flash.

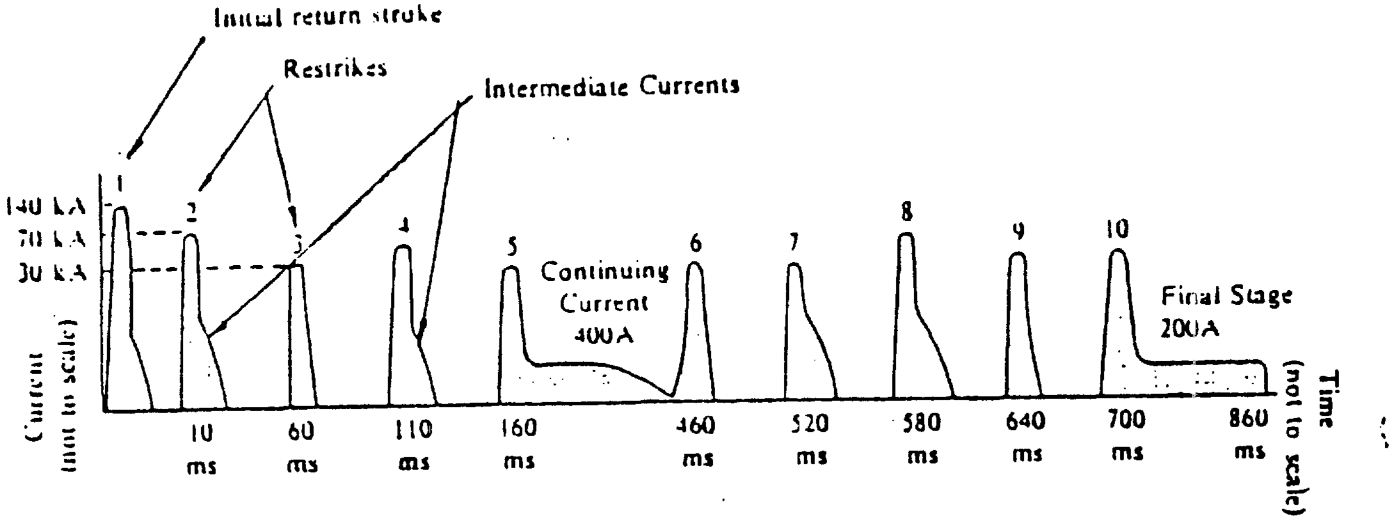
PARAMETERS FOR POSITIVE LIGHTNING FLASH MEASURED AT GROUND LEVEL

PARAMETERS		LIGHTNING PARAMETERS	
	UNIT	AVERAGE (50%)	SEVERE (2%)
Peak current	kA	25	170
Peak rate of rise	A/s	2.5×10^{7}	1.7×10^{10}
Time to peak	us	20	120
Total charge in flash	C	70	300
Action integral	A^2s	5×10^{5}	8×10^{6}
Flash duration	s	0.1	0.4

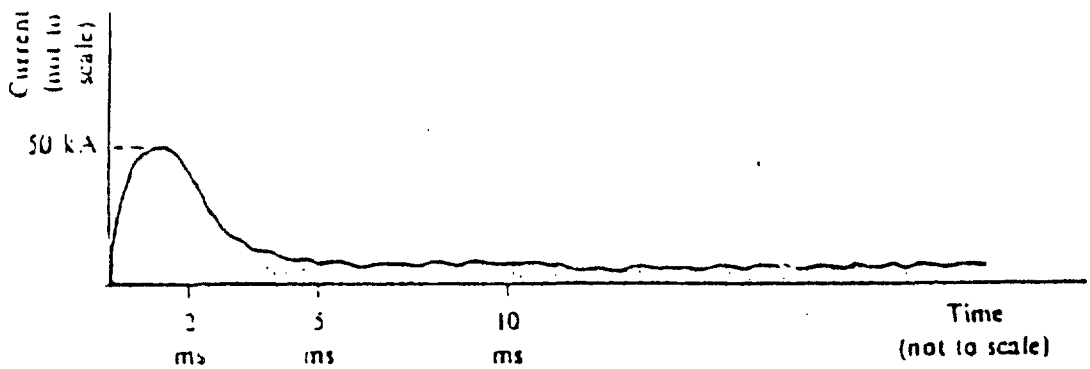
TABLE 2

Notes:

1. The proportion of positive flashes is approximately 10% of total flashes
2. The individual parameters indicated above are approximate and represent a consensus of experimental measurements. They do not necessarily occur together in one flash.



(A) REPRESENTATION OF THE NEGATIVE LIGHTNING FLASH CURRENT WAVEFORM (from "A Ground-Lightning Environment for Engineering Usage" by Cianos & Pierce)



(B) REPRESENTATION OF THE POSITIVE LIGHTNING FLASH CURRENT WAVEFORM

FIGURE 1: LIGHTNING FLASH CURRENT WAVEFORM

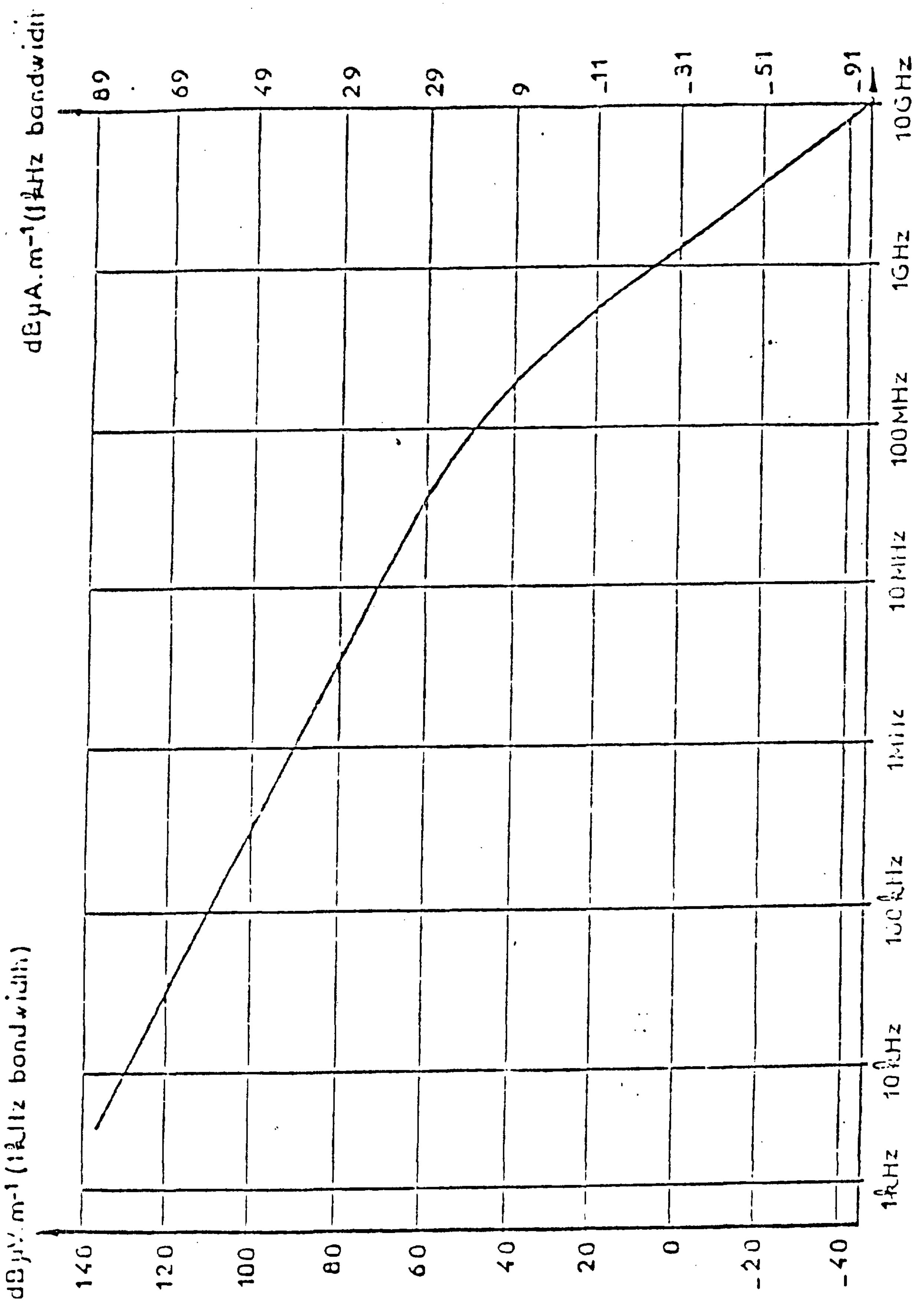


FIGURE 2: ENVELOPE OF PEAK FIELD INTENSITY VERSUS FREQUENCY EXPECTED AT GROUND LEVEL AT 1,5 TO 2 KILOMETERS DISTANCE FROM THE DISCHARGE.

MINIMUM DESIGN CRITERIA FOR MUNITIONS AND ASSOCIATED SYSTEMS

The following table defines the minimum design criteria parameters for munitions and associated systems intended for use by NATO forces. (See Notes 1 and 2)

PARAMETERS		UNIT	VALUES
Peak current		kA	200
Max di/dt	first return stroke	A/s	3×10^{10}
	subsequent strokes	A/s	1×10^{11}
Total Action Integral		A^2s	4×10^6 (See NOTE 3)
Continuing current	amplitude	A	500
	duration	s	0.5

TABLE 1: Minimum design criteria for munitions and associated systems.

NOTE:

1. The above table is derived from the basic parameters given in tables 1 and 2 Annex B.

2. The table is related only to direct and nearby strikes effects other than those due to mechanical excitation.

3. Munitions and associated systems which are intended only for airborne applications and are protected during storage, leading and prior to flight may be designed to an action integral reduced by a factor of 2 from that given in Table 1.

RATIFICATION AND IMPLEMENTATION DETAILS
STADE DE RATIFICATION ET DE MISE EN APPLICATION

NATION	NATIONAL RATIFICATION REFERENCE DE LA RATIFICATION NATIONALE	NATIONAL IMPLEMENTING DOCUMENT NATIONAL DE MISE EN APPLICATION	IMPLEMENTATION/MISE EN APPLICATION — FORECAST DATE DATE PREVUE			ACTUAL DATE DATE REELLE		
			NAVY MER	ARMY TERRE	AIR	NAVY MER	ARMY TERRE	AIR
BE	GSRL(BMS)-0914 of/du 28.9.90	STANAG 4236				9.93	9.93	10.90
CA								
DA	M.204.69-S.4236-ML4-14077 of/du 5.7.90	STANAG				1.91		
FR*	Nº 2-00-74-0166 ST/DASA/MMS of/du 16.12.92							
GE	BMVg Fü S IV 1 Az 03-51-60/4236 of/du 20.7.90		7.93	7.93	7.93			
GR								
IT	Prot.423/4-70178-STANAG of/du 10.2.93					2.93	2.93	2.93
LU								
NL	M90/1668/1016 of/du 27.7.90		3.93	3.93	3.93			
NO								
PO								
SP	NORMAT/0022/4236/01/00 of/du 21.11.91	STANAG	3.93	3.93	3.93			
TU								
UK	D/D Stan/341/8/4236 of/du 5.2.91	STANAG				3.93	3.93	3.93
US*	Ltr. SMCAR-QAS of/du 19.6.92	MIL-STD-1757A MIL-STD-1795A	3.93	3.93	3.93			

*See reservation overleaf/
Voir réserve au verso

RESERVATIONS/RESERVES

FRANCE:

As this STANAG does not take account of the multiburst environment, it will not be applicable to aeronautical equipment. It will be implemented only in the Navy and the Army.

FRANCE

Ce STANAG ne prenant pas en compte l'environnement "multi burst" ne sera pas appliqué pour le matériel aéronautique. Il ne sera mis en application que dans la marine et l'armée de terre.

UNITED STATES

With regard to Table 1, page C-1, the US will use a value of 2 $x10^6$ for the "Total Action Integral" and will use 0.4 sec. for the "Continuing Current Duration."

ETATS-UNIS

En ce qui concerne le tableau 1, page C-1, les Etats-Unis utiliseront Une valeur de 2 $x10^6$ pour l'"intégrale d'action totale" et 0,4 s pour la "durée du courant continu".